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VERWORN'S "GENERAL PHYSIOLOGY."

General Physiology. An Outline of the Science of Life. By Prof. Max Verworn. Translated from the second German edition by Dr. Frederic S. Lee. Pp. xvi + 615. (London: Macmillan and Co., Ltd., 1899.)

WE cordially welcome the appearance of an English translation of this well-known book. The first (German) edition appeared in 1894, and was noticed at some length in this journal (vol. li. p. 529). The interest which it excited is testified to by the practical fact that a second edition in German was called for in 1897, while translations into English, Italian and Russian have also appeared.

The second edition differs from the first only in detail. The general plan remains the same, though, as the author remarks in the preface, the more important results of the very large number of researches in the physiology of the cell which have appeared during the last few years have been added.

The scope of the book is "an attempt to treat general physiology as general cell-physiology," and thus to outline a field in which the various branches of special physiology might unite. The author is at some pains to define the cell as the unit of organised living matter—the smallest part which can maintain an independent existence; it is the "elementary organism." Having described this unit, and discussed its structure and chemical and physical constitution and the way in which the substance of which it is composed differs from non-living substance, the author proceeds to a consideration of the phenomena which are manifested by cells in general. He is thus led to a discussion, firstly, of the internal phenomena of life in their most general aspect—of change of substance or metabolism, of change of form, and of change of energy; and, secondly, of the external relations of living matter, of food, of effects of temperature, &c., of stimuli, of the origin of life on the earth, and of the process of dying. Lastly, he returns to a consideration of the nature of the material of the cell, and seeks there an explanation of these internal and external phenomena. These inquiries are sufficiently wide; but the author, not content with them, includes an interesting history of physiological research, in which he rightly endeavours to justify his own standpoint by an appeal to the development of the science; and a discussion, in true Ercles vein, of the relation of physiological research to metaphysics in which, among other things, the investigator is invited to "get rid of the error of the existence of a physical world outside the mind"!

Those who have made acquaintance with Prof. Verworn's views in other and earlier publications, as, for instance, in papers published in the *Monist* (*cf.* NATURE, li. p. 58), will not be surprised to learn that the tone of the book is somewhat aggressive. He has set himself the task of recalling physiologists from the barren field of "one-sided specialisation," whatever that may mean, to a renewed consideration of the ultimate problems of life. He is impatient with the "impotence of the physiology of to-day in the presence of the simplest vital processes." The outworks are down, why do the workers stay prying into the ruins when they should press on to attack the central citadel, the cell, wherein the simple secrets of these simplest of processes are hidden?

No fault can be found with the purpose which is outlined here, but unfortunately the reader's sympathies are apt to be lessened by a lack of restraint and reticence in the advocacy. There is an unpleasant tone of special pleading running through the pages, which inevitably raises the suspicion that the author's outlook is perhaps not so broad as he would have us believe.

A good wine needs no bush, and the virtues of an endeavour to bring together all that is known of the general properties of living matter suffer when heralded by an impeachment of the past achievements of physiology which is phrased so as to convey the idea that the nature of the processes which constitute life has not been touched on. In point of fact, the knowledge gained, amongst other things, of the internal respiration of muscle, of the automatic phasic activity of the cardiac and other tissues (due, by the way, mainly to the work of Gaskell, and not to that of Engelmann, as the author states), and of the special processes of storage and discharge in glandular organs, has led to a first approximate conception of the character of the changes, both in matter and energy, which waits for further development, not upon the labour of biologists, but upon that of workers in the domain of molecular physics.

It is possible that the central idea of the book—the assertion of the identity of general physiology with cell physiology—is founded upon a misconception, and we are inclined to doubt whether any special virtue is likely in the future to flow from the study of the cell. If the cells in question form part of tissues or organs, then the methods are the methods which have been employed in the past. The study of the cardiac muscle cell is the study of the heart, of the secreting cell that of the gland which holds it, and so on. Practically, as one learns by perusing Prof. Verworn's pages, what is really new in his method is confined to the exaltation of the importance of the study of the cell when it is an independent individual, such as one finds in the members of the Protozoa. In this field he has himself laboured with no small measure of success. The phenomena exhibited by free-living cells are unquestionably of surpassing interest, but, unfortunately, the study of the relatively diffuse activities which they manifest must be of secondary importance, seeing that the facts which are gleaned can only be interpreted by the aid of that insight into the finer anatomy of function which springs from a study of the highly specialised organs of the higher types where the activities of living matter are, as it were, analysed for us.

This is not the only drawback. There is another, and perhaps more serious one, which the author nowhere stops to discuss. It lies in the difficulty which exists when minute forms are used for experiment in deciding how far a given result is a true physiological reaction to a stimulus, and how far it is a purely mechanical effect. For instance, under the heading of galvanotaxis, and in the section dealing with the general effect of electrical stimuli, a description is given of the way in which animalculæ become grouped round one of the poles, while individuals suffer actual alteration in shape under the influence of a constant current. But, as Faraday was the first to show, small particles of any kind are driven to one or other pole when suspended in fluid through which a current is passed, and a rod of jelly suffers compression at one end and expansion at the other under the mechanical stresses produced by the passage of a current.

The general tone of the book is inspired by an impatience with the laggard pace of knowledge—the "foster-child of silence and slow time," if one may wrest a phrase of Keats from its setting—which prompts the taunt that the physiology of to-day is impotent in face of the simplest vital processes. Unfortunately, it is not controlled by a true feeling for the relation of the knowledge of living matter to the progress of the general knowledge of matter. The tools with which the attempt to fashion a dynamical explanation of the phenomena of life must be made are themselves still in the making. It is barely ten years since what was practically the new science of molecular physics was founded at the meeting-place of chemistry and physics by the labours of Guldberg and Waage, Arrhenius, van 't Hoff, Gibbs, Ostwald and others. On the growth of this science the biologist must wait, and, though the advances which it has made are prodigious, they are concerned wholly with the crystalloid type of matter—they have not yet embraced the colloid type which is the physical basis of life.

The completeness of our ignorance of the latter type is manifested with almost dramatic force when one finds all that is known of colloidal matter lying in the compass of a page or two of a text-book such as that of Ostwald or of Nernst, whereas the account of the crystalloid type stretches to many hundreds! Reproaches and hasty generalisations are equally out of place in the face of this colossal ignorance of the elements of the problem; and one feels the practical wisdom of physiological workers in devoting themselves to what may be called the anatomy of function—that is, the interpretation of organ and tissue activities in terms of the fundamental properties of living matter, rather than in kicking against the barriers which the general state of knowledge opposes to the translation of these fundamental properties into terms of matter and motion.

The same lack of a sense of the historical position of biology caused Bunge to drift into vitalism, which at any rate has the merit of recognising the difficulties which stand in the way of a dynamical explanation of metabolism, irritability, and the recurrent cyclic character of the phenomena of life.

Prof. Verworn, however, is impelled to the opposite extreme—a materialism, often rash, which leads him to a disastrous quest for "simple explanations," in which his knowledge too frequently becomes wire-drawn to the breaking point. The "mechanical explanation" which he offers of the "so-called" selection of food will serve as an instance. A cell bathed by a nutrient fluid such as, *e.g.*, an epithelial cell absorbing material from the lumen of the intestine, is likened to a crystal growing in its mother liquor. Like its analogue, it withdraws only special substances from the common nutrient fluid, "as is evident from the fact that gland, muscle and cartilage cells produce wholly different and characteristic substances." Hence the conclusion that the selection of food is only a special manifestation of chemical affinity, and that "it is an absolutely necessary consequence of the fact that the living substance of every cell possesses its own specific composition and its own characteristic metabolism." So in place of the healthy recognition of a difficulty we are offered a cumbrous platitude and a leap in the dark!

The simple explanation which is offered of the fact "which must otherwise appear very wonderful" (*sic*), that among the innumerable swarm of spermatozoa cast into the sea, every species finds its proper ovum, also deserves mention. It "is explained very simply by the further fact that every species of spermatozoon is chemiotactic to the specific substances that characterise the ovum of the corresponding species." The robe of modesty is more fitting than the gown of counsel for explanations like these!

In other cases the haste for simple explanations leads to a mode of treatment of problems of acknowledged difficulty which intensifies the obscurity. Thus some space is devoted to urging that there is no distinction between the motor impulse or the electric current in their action upon, for instance, muscle fibres and that relation between motor nerve cell and muscle fibres which, when it is broken by severance of the connecting nerve, causes degeneration of the latter. This view is distinctly opposed to the results of recent work upon muscular tone, and upon the effects of section of the roots of spinal nerves which tend to emphasise the distinction between the calling out of special activity by special nervous impulses and the fact that many highly specialised cells are dependent for their continued well-being, even for their capacity to respond to stimuli, upon their functional continuity with other and totally dissimilar cells. We are ignorant of the nature of the latter relation, though it may well be one of simple dynamical equilibrium rather than one dependent upon the passage of nervous impulses. But Prof. Verworn starts in a panic from this unsolved problem. He sees in it a piece of the old mysticism of the vitalists, and, in order to compass a simple explanation, trophic relations are grouped with the action of electric and chemical stimuli and of food into one class which lacks both order and form.

In spite of these defects in general tone, the pages of the book furnish abundant justification for the success which it has already attained. The point of view which the author has adopted has led him to bring together a body of facts, many of them little known, in a manner which cannot fail to be stimulating and suggestive to both physiologists and morphologists. Many gems of thought, too, are to be found, especially in the later chapters. The sections on the directive effects of unilateral stimulation, chemiotaxis, barotaxis, &c., are singularly interesting, and so too is the conclusion which is drawn from the facts, namely, a general application of the principle of the specific energy of sense-substances.

> "All living substance possesses specific energy in Müller's sense: with certain limits wholly different stimuli call forth in the same form of living substance the same phenomena, while, conversely, the same stimulus in different forms produces an effect wholly different and characteristic for every form."

The treatment of the dynamics of movement as a polar change in the resultant of the anabolic and katabolic processes in the cell, or "biotonus," as the author calls their algebraical sum, is equally illuminating, as are also parts of the mechanics of cell metabolism.

The pages dealing with actual facts, which after all make up by far the greater part of the book, possess an enticing feeling of freshness and novelty which is born of the fact that the author's special studies have lain out of the beaten track. For this and for the intrinsic interest of the facts themselves we feel grateful to him, and we heartily wish success to the English edition. The translation bears abundant evidence of the care which Prof. Lee must have lavished upon it. It is a monument of clearness throughout. W. B. HARDY.

OUR BOOK SHELF.

Living Pictures. By H. V. Hopwood. Pp. xii+275. (London: *The Optician and Photographic Trades Review*, 1899.)

THIS is a very interesting review of the gradual evolution of the various instruments which have been invented for the portrayal of objects in motion, from the earliest times to the present day. The work may be divided into two parts, of which the first, including Chapters i.–iii. (pp. 1–109) deals with the more distinctly historical aspect of the subject, while the remaining chapters (iv.–vii.) are devoted to a very minute description of all the important machines in present use.

Chapters i. and ii., on the "Persistence of Vision," &c., contain a lucid account of the principles governing the phenomenon of a succession of different views of the same object giving the impression of the object being in motion. In this part all the instruments, whether as toys or scientific apparatus, are described in the order of their invention, beginning with the simple colour tops and thaumatrope put forward as early as 1826. The host of improvements from this time up to about 1878 were attempts to remedy the difficulty of so small a percentage of light passing the two slits at first used for the intermittent view. This section concludes with descriptions of the modern mutoscope and viviscope.

Chapter iii. (pp. 43–109) commences with the invention of "chronophotography," and gives a complete description of the more important of the inventions brought out from 1865–1895. The mechanical details in connection with the alternate exposure and movement of the sensitive surface receive special attention, the difficulty of following these being greatly lessened by the numerous illustrations accompanying the text.

Chapter iv. is devoted to present-day apparatus, and all the machines which have appeared before the public receive ample notice, in most cases accompanied by a woodcut showing the internal arrangements.

Chapters v. and vi. deal with the processes adopted in making the films, their exposure, development, printing, &c., and also give ample practical instructions for exhibiting the pictures in the lantern.

At the end of the volume two most useful appendices are given. The first is a "Chronological Digest of British Patents," giving a short *résumé* of all specifications taken out in connection with living pictures from the time of Fox Talbot (1851) to the end of December 1898.

The second appendix is an annotated bibliography of all publications (British and foreign) from 1825 to the present time, which bear on the subject.

The numerous illustrations (242), which are well chosen and very clearly printed, render the following of the necessarily somewhat technical matter exceedingly interesting even to the non-expert. The book will be welcomed by many to whom the methods of cinematography are a mystery, as by its aid any one even strange to the subject may easily understand the working of any of the machines in past or present use.

Tables and Data. By W. W. F. Pullen. (Manchester: Scientific Publishing Company, 1899.)

IN these eighty-seven pages Mr. Pullen brings together tables and data which will be found very serviceable in engineering laboratory work and in the solution of class problems and exercises in mechanical engineering. Points perhaps of special mention are that the general steam table is carried up to 300 lbs. per square inch; the diagram for determining the dryness of steam with the throttling calorimeter is plotted on a large scale, and the melting points of various substances has been revised by Sir William Roberts-Austen. For facility of reference the British and metric measures are placed side by side. The remaining portion of the book is devoted to mathematical notes on mensuration, geometry, trigonometry, &c., with a synopsis of mathematical data. At the end are added a few extra pages, some of which are blank, while on others are printed diagrams of millimetre paper, for the insertion of any additional curves the student may wish to insert. Not only engineering students, but others should find the contents of this book a useful laboratory *vade-mecum*.

LETTERS TO THE EDITOR.

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Halo Round a Shadow.

IN your issue of this week Prof. S. Newcomb draws attention to the halo which an observer often sees round the shadow of his own head when the ground on which the shadow falls is covered with vegetation or any obstructions which can themselves cast shadows.

In a letter to NATURE in 1878 or 1879 (I have not the reference by me) I mentioned this phenomenon, giving the same explanation as your recent correspondent, and adding that the angular width of the halo was settled by the ratio of the mean diameter of the obstructions to their distance from their own shadows.

The halo (or spot of light, if the observer is too far off for his own shadow to show) can be seen very well when the ground is covered with heather or bracken whose twigs and leaves are small compared to their height above the ground.

3 Victoria Street, S.W., October 6. A. MALLOCK.

The Skull of Hatteria.

IT may be worth while to draw the attention of naturalists to an omission in the figures of the skull of that archaic reptile, the Tuatara, that occur in two recent text-books of somewhat wide circulation, viz. Parker and Haswell's "Text-Book of Zoology" and Reynolds's "The Vertebrate Skeleton." These figures are either copied or redrawn from Zittel's figure published in his well-known work on Palæontology. This figure appears to have been drawn from an imperfect specimen, as the "transverse" (or transpalatine) bone is omitted in the ventral view; it is *apparently* represented in the dorsal view, however, though there is no index line in the original. The bone, though of considerable size, very readily drops out of a thoroughly macerated skull, from which the figure was no doubt drawn. There is really no excuse for our English authors borrowing the figure from a German book in this instance, for Dr. Günther's picture of the skull published in the *Phil. Trans.*, vol. clxvii., is perfectly accurate, except in regard to nomenclature of some of the bones, while Zittel's is most indistinct.

Dunedin, N.Z., August 30. W. BLAXLAND BENHAM.